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Subject: Dermal Transfer Factor for Cotton Scouts

Dislodgeable foliar residues (DFR) are defined as the amount of pesticide residue that can be removed by an aqueous detergent rinse from treated foliage surfaces (on both sides), and are normally expressed in units of µg pesticide per cm² leaf surface. In performing worker exposure assessment, this measure is frequently utilized as a surrogate estimate for dermal exposure where actual exposure data are not available. When coupled (multiplied) with a dermal transfer factor (TF), this environmental index can be readily converted to hourly potential dermal exposure of a worker reentering a treated field. As expected, the accuracy of this exposure estimate would depend not only on the value of the DFR used, but also on that of the TF predetermined. This memorandum is to present the basis for estimation of TF for cotton scouts that was determined using the data from a series of field studies by Ware, *et al.* [1-3]. In the Ware *et al.* series, the cotton scouts in Arizona were monitored for dermal exposure to three organophosphates: monocrotophos, ethyl parathion, and methyl parathion. The data from this series were considered here because studies of this type were related to cotton scout exposure.

The required DFR and dermal exposure data (by body part), together with the resultant TF, are presented in Tables 1-3. In this determination, the TF was defined simply as the ratio of hourly dermal exposure to DFR measured at a given time (unless otherwise noted). Where data permitted, a simple statistical analysis was performed instead, in which the hourly dermal exposures were linearly regressed on the DFR for a set of sequential observations within a given trial. The coefficient (i.e., the slope) obtained from the regression was then assumed to be the expected value of the various TF taken from the set; and this statistic was interpreted as the ratio of hourly dermal exposure to DFR at 1.0 µg/cm². This interpretation was based on the assumption that *a fair* estimate of the DFR, at most any practical time post-application and for most any practical application rate, is in the 1.0 µg/cm² range; it was also assumed that a conservative estimate (i.e., a slightly higher ratio) would be more desired (as the associated intercept was not taken into account here). The results of the regression analyses performed are graphically presented in Figures 1-3. As an example illustrating the use of these results, hand exposure to methyl-parathion based on the repression in Figure l would be 941.8 µg/hr per 1.0 µg/cm² of DFR; consequently, the expected ratio or TF would be 941.8 µg/cm². (Note that the data from only two of the three studies by Ware *et al.* were used in this determination. Their second study does not provide the proper data for TF determination; it is referenced here as additional background material only.)

The geometric mean TF calculated from the individual TF shown in Tables 1-3 are as follows: 950 cm²/hr for bare hands; 1,020 cm^2/hr for the upper body; and 9,640 cm²/hr for the lower body. The three geometric mean TF were calculated from dermal exposures to all three organophosphates at all given hours post-application in an effort to offer a broader application as a *surrogate* conversion coefficient.

The TF calculated from the Ware *et al.* series were based on residues extracted from (hexane) hand washes and from washes of short-sleeved T-shirts and blue-jean trousers (as worn by the cotton scouts); these TF hence did not account for exposures of the head, face, neck, arms, and feet. This limitation may not pose a practical problem in exposure conversion, however, since cotton scouts are likely to wear *complete* work clothing (including a hat) when

Table 1. Dermal Transfer Factors for Cotton Scouts Exposed to Methyl-Parathion, by Body Part

Hours Post-Application	DFR (µg/cm²)[d]	Hands[a] (mg/hr)	Hands[a] TF (cm²/hr)[e]	Upper Body[b] (mg/hr)	Upper Body[b] TF (cm²/hr)[e]	Lower Body[c] (mg/hr)	Lower Body[c] TF (cm²/hr)[e]
			Ware, et al, (Trial I)[1]				
0	2.390	3.41	1,426.8	0.83	347.3	21.74	9,095.4
4	2.845	3.59	1,261.2	0.67	235.5	16.54	5,815.1
			Ware at al. (Trial II) [1]				
0	2.720	2.47		1.43		19.17	
12	1.605	1.30		0.63		12.63	
24	1.345	0.74		0.39		6.17	
48	0.865	0.34		0.20		4.17	
72	0.460	0.16		0.09		2.16	
∞[f]	0.000	0.00	-	0.00		0.00	
		slope	*941.8*[g]	*slope*	*533.8*[g]	*slope*	7,337.5[g]
			Ware et al, [3]				
12	0.675	0.51	755.6	2.17	3,211.9	8.16	12,094.8

[a] based on hand washes.

[b] based on residues extracted from washes of short-sleeved T-shirt; excluding the head, face, neck, and arms.

[c] based on residues extracted from washes of blue-jean trousers; excluding the feet.

[d] measured from the canopy (vs. bottom) leaf samples or, where applicable from averaging the middle and top canopy samples; based on both sides of the treated leaf surfaces.

[e] unless otherwise noted, TF (transfer factor) is defined as the ratio of hourly dermal exposure to DFR measured at the same time; the ratio presented here is based on the DFR and exposure values carried to four decimal places.

[f] a hypothetical observation (at some long hours post-application) where a zero value is expected for both the DFR and the hourly dermal exposure.

[g] determined from one of the linear regressions shown in Figures 1-3; here the slope is treated as the expected value of the various TF taken from a set of sequential observations within a given trial, with this regression coefficient being interpreted as the ratio of hourly dermal exposure to *DFR at 1.0* µg/cm² [see discussion in text].

Table 2. Dermal Transfer Factors for Cotton Scouts Exposed to Ethyl-Parathion, by Body Part

Hours Post-Application	DFR (µg/cm²)[d]	Hands[a] (mg/hr)	Hands[a] TF(cm²/hr)[e]	Upper Body[b] (mg/hr)	Upper Body[b] TF(cm²/hr)[e]	Lower Body[c] (mg/hr)	Lower Body[c] TF(cm²/hr)[e]
			Ware, et al, (Trial II)[1]				
0	2.005	1.91		1.02		15.05	
12	1.380	1.16		0.51		10.63	
24	1.295	0.74		0.35		6.19	
48	0.990	0.43		0.22		4.58	
72	0.525	0.23		0.13		3.01	
∞f	0.000	0.00		0.00		0.00	
		slope	*956.6*[g]	*slope*	490.1[g]	*slope*	7,550.1[g]
			Ware et al.[3]				
24	0.138	0.044	315.9	0.053	382.6	1.18	8,565.2
48	0.073	0.035	488.3	0.035	482.8	0.56	7,715.9

[a-g] see Table 1 for footnotes.

Table 3. Dermal Transfer Factors for Cotton Scouts Exposed to Monocrotophos, by Body Part

Hours Post-Application	DFR (µg/cm²)[d]	Hands[a] (mg/hr)	Hands[a] TF(cm²/hr)[e]	Upper Body[b] (mg/hr)	Upper Body[b] TF(cm²/hr)[e]	Lower Body[c] (mg/hr)	Lower Body[c] TF(cm²/hr)[e]
			Ware et al.[3]				
48	0.250	0.42	1,664.0	2.70	10,800.0	4.04	16,160.0
72	0.303	0.61	2,003.3	2.68	8,859.5	5.74	18,975.2

[a-e] *see* Table 1 for footnotes.

Fig 1. Linear Regression of Hand Exposure on Parathion Foliar Dislodgeables

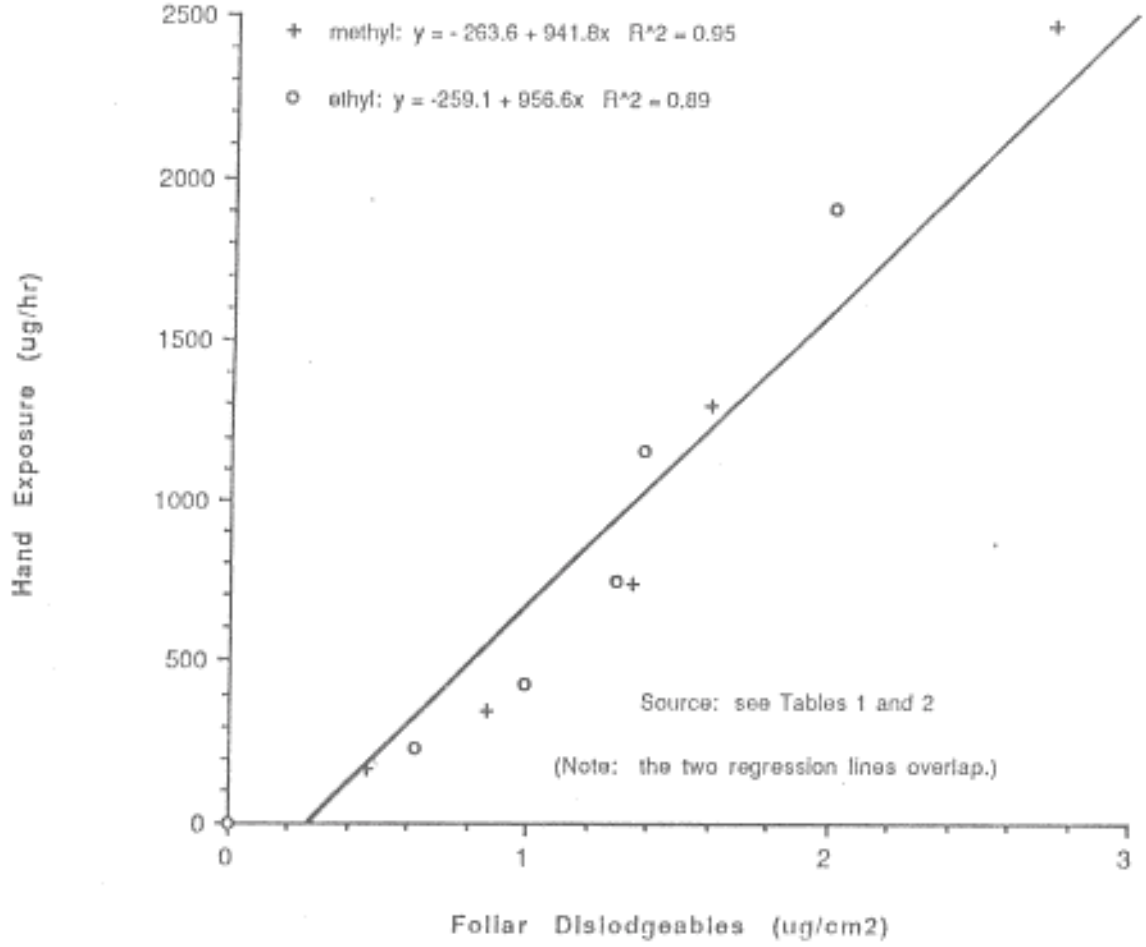


Fig 2. Linear Regression of Upper Body Exposure on Parathion Foliar Dislodgeables

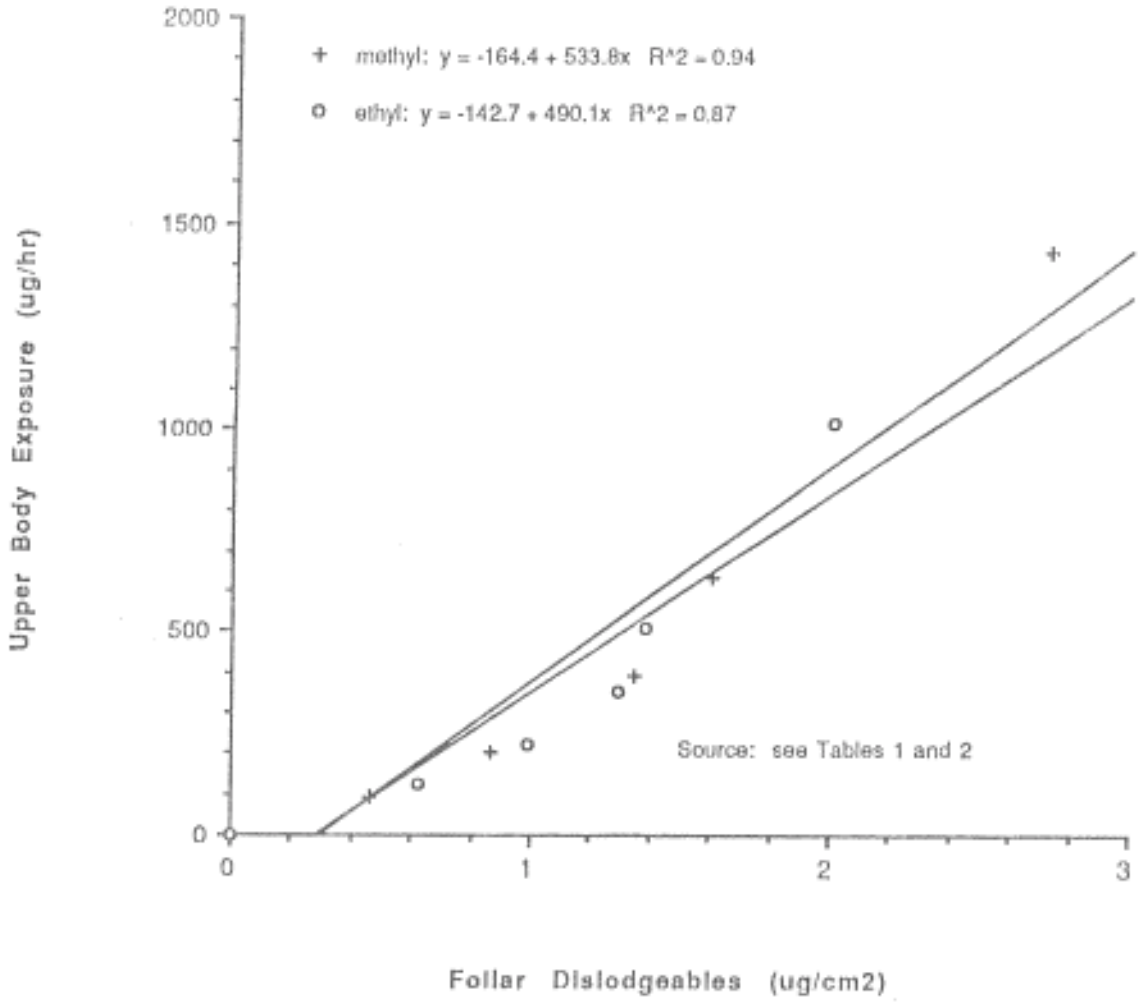
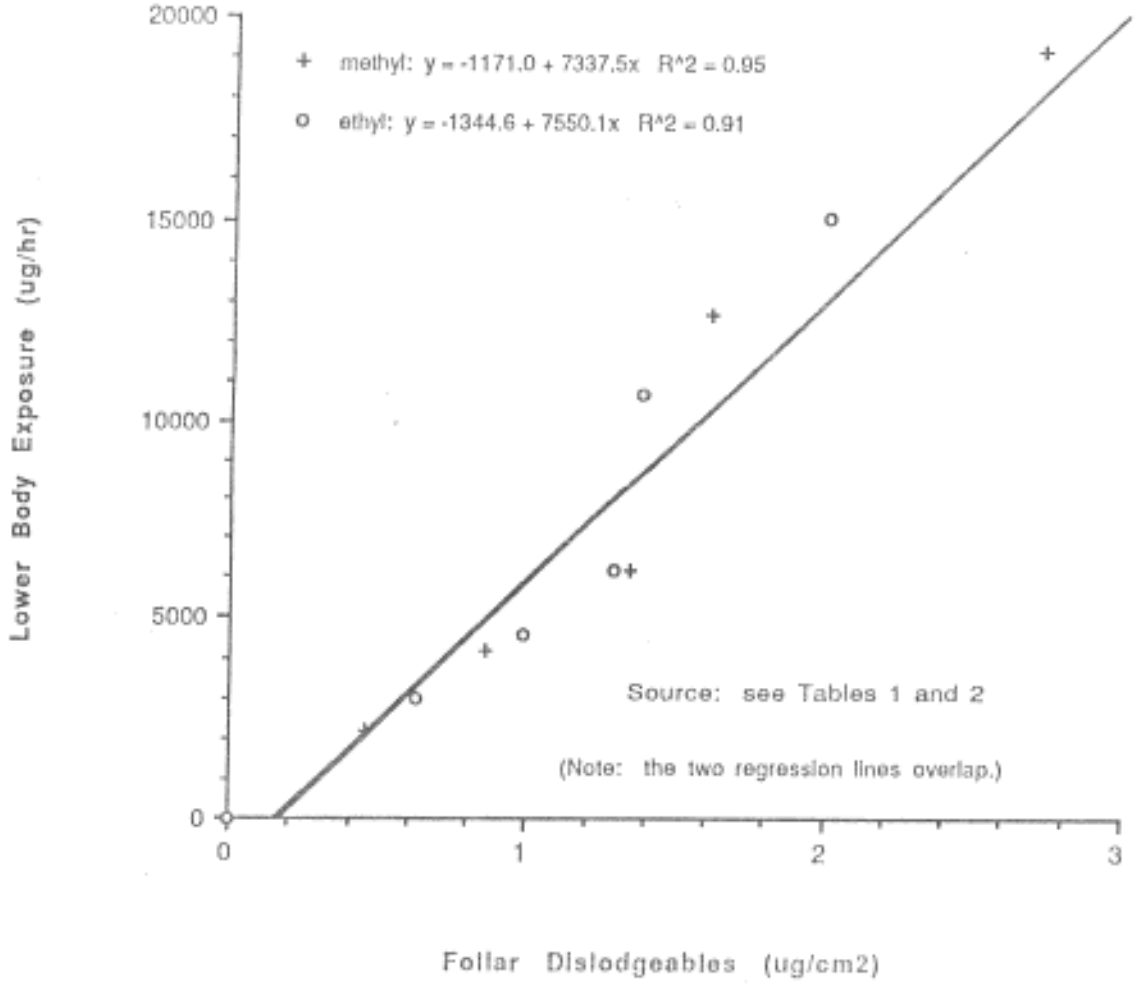


Fig 3. Linear Regression of Lower Body Exposure on Parathion Foliar Dislodgeables



working in a field in which maturing cotton is at least 4 or 5 foot tall; in this type of work environment, they are also expected to keep their face and neck away from cotton foliage. It is also believed that the TF so calculated were necessarily underestimated by a factor equivalent to whatever the percent clothing permeation that one would assume; that is, by the amount of monocrotophos or parathion residue that had penetrated through the sampling garments. In the Ware *et al.* series, dermal exposures were monitored by measuring only the pesticide residues that were *left* in or on the clothing after the sampling period, and not by measuring the *total* amount that had come in contact with the garments during that period. The amount of TF so underestimated may not be considered significant for *protected* cotton scouts, however, since the overall underestimation effect will be equivalent to the assumed percent clothing permeation *taken to the second power;* that is, the second multiplier is included here to account for clothing permeation *per se.*

In conclusion, the whole body TF for *potential dermal* exposure of cotton scouts may be assumed to be approximately 11,610 cm^2/hr, or simply the sum of the individual geometric mean TF calculated for bare hands (950 cm^2/hr), the upper body (1,020 cm^2/hr), and the lower body (9,640 cm^2/hr). These geometric mean TF may be used as *the interim* conversion coefficients for the various body parts until further studies of this type become available.

References

1. Ware GW, Morgan DP, Estesen BJ, *et al.* (1973). Establishment of Reentry Intervals for Organophosphate-Treated Cotton Fields Based on Human Data: I. Ethyl and Methyl Parathion. *Arch Environ Contam & Tox* 1:48-59.

2. Wale GW, Morgan DP, Estesen BJ, *et al.* (1974). Establishment of Reentry Intervals for Organophosphate-Treated Cotton Fields Based on Human Data II. Azodrin, Ethyl and Methyl Parathion. *Arch Environ Contain & Tox* 2:117-129.

3. Ware GW, Morgan DP, Estesen BJ, et *al.* (1975). Establishment of Reentry Intervals for Organophosphate-Treated Cotton Fields Based on Human Data: III. 12 to 72 Hours Post-Treatment Exposure to Monocrotophos, Ethyl and Methyl Parathion. *Arch Environ Contam & Tox* 3:289-306.

cc: Bob Krieger